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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/710,210	06/25/2004	Timothy J. Dalton	FIS920040128US1	4209

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EXAMINER	
DANG, PHUC T	

ART UNIT	PAPER NUMBER
2818	

DATE MAILED: 04/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/710,210	DALTON ET AL.	
	Examiner	Art Unit	
	PHUC T. DANG	2818	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *election filed on March 2, 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,11,13 and 19* is/are rejected.

7)☒ Claim(s) *3-10,12,14-18 and 20* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 June 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *062504*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse filed on March 2, 2005 has been considered and found persuasive.

The restriction filed on February 11, 2005 has been withdrawn from the last Office action as requested by Applicants.

2. Claims 1-20 are currently pending in the application.

Oath/Declaration

3. The oath/declaration filed on June 25, 2004 is acceptable.

Information Disclosure Statement

4. The office acknowledges receipt of the following items from the applicant:

Information Disclosure Statement (IDS) filed on June 25, 2004.

Specification

5. The specification has been checked to the extent necessary to determine the presence of all possible minor errors. However, the applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary

skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1, 11 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ishihara (U.S. Patent No. 6,156,646).

Ishihara discloses a method of forming substantially cylindrical conductors comprising :

providing an intermetal dielectric layer (3, Fig. 3A);

depositing a hard mask layer (4, Fig. 3A) over the intermetal dielectric layer (3, Fig. 3A);

etching an opening (5, Fig. 3B) in the hard mask layer (4, Fig. 3B) in a location corresponding to where a substantially half cylindrical wire (6, Fig. 3B) is to be formed;

isotropically etching the intermetal dielectric layer (3, Fig. 3B) in a location corresponding to the opening at a substantially constant rate to form a substantially half cylindrical trench opening (6, Fig. 3B) in the intermetal dielectric layer (3, Fig. 3B) having dimensions larger in comparison to dimensions of the opening (6, Fig. 3B) in the hard mask layer (4, Fig. 3B), and

filling the substantially half cylindrical trench opening (6, Fig. 3B) with a metal to form the substantially half cylindrical wire in the intermetal dielectric layer (3, Fig. 4C).

Ishihara discloses all the features of the claimed invention as discussed above with a metal in the half cylindrical opening but does not disclose a high conductivity metal in the half cylindrical opening.

However, a step of coverage of the contact hole by growing the metal layer at a temperature at 400°C or higher as suggested by Ishihara (see col. 2, lines 45-55) is considered

will be obviously resulting a high conductivity metal in the half cylindrical opening for protecting cracking in the intermetal dielectric [see col. 6, lines 58-64].

Regarding claim 11, Ishihara discloses further including depositing a conductive liner layer (8 and 9, Fig. 4A) within the substantially half cylindrical trench opening (6, Fig. 4A) prior to filling the substantially half cylindrical trench opening (6, Fig. 4A) with the high conductivity metal (10, Fig. 4C).

Regarding claim 19, Ishihara discloses a conductive interconnect structure for preventing cracks in a dielectric layer on a substrate comprising:

at least a first intermetal dielectric layer (3, Fig. 3A);

a substantially cylindrical trench opening (6, Fig. 3B) in the at least first intermetal dielectric layer (3, Fig. 3B);

a metal filling (10, Fig. 4C) the substantially cylindrical trench opening (6, Fig. 4C) to form a substantially cylindrical wire in the at least first intermetal dielectric layer (3, Fig. 4C), the substantially cylindrical wire (6, Fig. 4C) substantially avoiding propagation points for starting cracks in the at least first intermetal dielectric layer (3, Fig. 4C).

Ishihara discloses all the features of the claimed invention as discussed above with a metal in the half cylindrical opening but does not disclose a high conductivity metal in the half cylindrical opening.

However, a coverage of the contact hole by growing the metal layer at a temperature at 400°C or higher as suggested by Ishihara (see col. 2, lines 45-55) is considered will be obviously

resulting a high conductivity metal in the half cylindrical opening for protecting cracking in the intermetal dielectric [see col. 6, lines 58-64].

7. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ishihara in view of Jeng et al., hereinafter "Jeng" (U.S. Patent No. 5,818,111).

Regarding claim 2, Ishihara discloses all the features of the claimed invention as discussed above, but does not disclose the intermetal dielectric layer comprises a low-k intermetal dielectric layer.

Jeng, howver, discloses the intermetal dielectric layer comprises a low-k intermetal dielectric layer [col. 2, lines55-62].

It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching of Ishihara discussed above such that the intermetal dielectric layer comprises a low-k intermetal dielectric layer as taught by Nakasuji for a purpose of preventing cracking in the intermetal dielectric layer.

8. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Huang (U.S. Patent No. 6,441,494) in view of Ishihara (U.S. Patent No. 6,156,646).

Huang discloses a method of forming substantially cylindrical conductors comprising:

providing an intermetal dielectric layer (12, Fig. 3);

providing at least a second intermetal dielectric layer (18, Fig. 3);depositing a hard mask layer (20, Fig. 3) over the at least intermetal dielectric layer (18, Fig. 3);

etching an opening (30, Fig. 3) in the hard mask layer (20, Fig. 3) in a location corresponding to where a substantially half cylindrical wire is to be formed;

sequentially etching the at least second (18, Fig. 3) and first intermetal dielectric layer (12, Fig. 3) to form a substantially cylindrical trench opening (30, Fig. 3B) traversing the at least second intermetal dielectric layer (18, Fig. 3) and extending in the first intermetal dielectric layer (12, Fig. 3), the substantially cylindrical trench opening (Figs. 4-8) having dimensions larger in comparison to dimensions of the opening (30, Figs. 4-8) in the hard mask layer (4, Figs. 4-8), and

filling the substantially half cylindrical trench opening (30, Fig. 8) with a metal (40, Fig. 8) to form the substantially half cylindrical wire in the at least second and first intermetal dielectric layer (12, Fig. 8).

Huang discloses all the features of the claimed invention as discussed above with a metal in the half cylindrical opening but does not disclose a high conductivity metal in the half cylindrical opening.

However, Ishihara discloses a step of coverage of the contact hole by growing the metal layer at a temperature at 400°C or higher (see col. 2, lines 45-55) is considered will be obviously resulting a high conductivity metal in the half cylindrical opening for protecting cracking in the intermetal dielectric [see col. 6, lines 58-64].

Allowable Subject Matter

9. The following is a statement of reason for the indication of allowable subject matter:

Claims 3-10, 12, 14-18 and 20 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening.

None of the Prior Art made of record discloses removing the hard mask layer and a portion of the high conductivity metal as cited in claim 3 and the intermetal dielectric layer comprises a SiwCxOyHz based intermetal dielectric layer wherein w, x, y and z range from about 0-1, the SiwCxOyHz based intermetal dielectric layer being isotropically etched using an etchant selected from the group consisting of an aqueous dilute HF and a vapor HF as cited in claim 4 and the intermetal dielectric layer comprises an organic polymer intermetal dielectric layer, the organic polymer intermetal dielectric layer is isotropically etched using an etchant selected from the group consisting of an H , N , 0 , He and Ar plasma as cited in claim 7 and the opening in the hard mask layer has a width "w1" and the substantially half cylindrical trench opening has a depth "d" and a largest width "w2" the largest width "w2" being a function of the opening in the hard mask layer represented as "w2" = "w1" + (2)(d) as cited in claim 10 and a step including the steps of removing any remaining hard mask layer, moving a portion of the intermetal dielectric layer at least in a location surrounding the substantially half cylindrical wire, thereby exposing a top surface of the substantially half cylindrical wire; etching the exposed top portion of the substantially half cylindrical wire to transform the substantially half cylindrical wire to a substantially cylindrical wire; and depositing additional dielectric material to at least encapsulate the substantially cylindrical wire as cited in claim 12 and a step including a third intermetal dielectric layer over the second intermetal dielectric layer, whereby the second intermetal dielectric layer selectively etches faster than the first and third intermetal dielectric layers so that the etch front partially undercuts bottom corner portions of said second intermetal dielectric layer for forming the substantially cylindrical trench opening as cited in claim 14 and

the at least second dielectric layer comprises a first graded dielectric layer having at least one constituent element thereof varied in concentration as the first graded dielectric layer is deposited over the first dielectric layer, the at least one constituent element being varied in a manner that allows the first graded dielectric layer to etch slowest at a top surface of the first graded dielectric layer and fastest at a bottom surface of the first forming the graded dielectric layer, for substantially cylindrical trench opening as cited in claim 17 and a step including at least a second intermetal dielectric layer over the first intermetal dielectric layer, the substantially cylindrical trench opening traversing through the at least second intermetal dielectric layer and extending into the first intermetal dielectric layer such that the substantially cylindrical wire resides in both the first and the at least second intermetal dielectric layers as cited in claim 20.

Claims 5-6, 8-9, 15-16 and 18 are depend on directly or indirectly claims 7, 14 and 17, then they also would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phuc T. Dang whose telephone number is (571) 272-1776. The examiner can normally be reached on 8:00 am-5:00 pm.

11. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David C. Nelms can be reached on (571) 272-1787. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9306 for regular communications and After Final communications.

12. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Phuc T. Dang PD

Primary Examiner

Art Unit 2818